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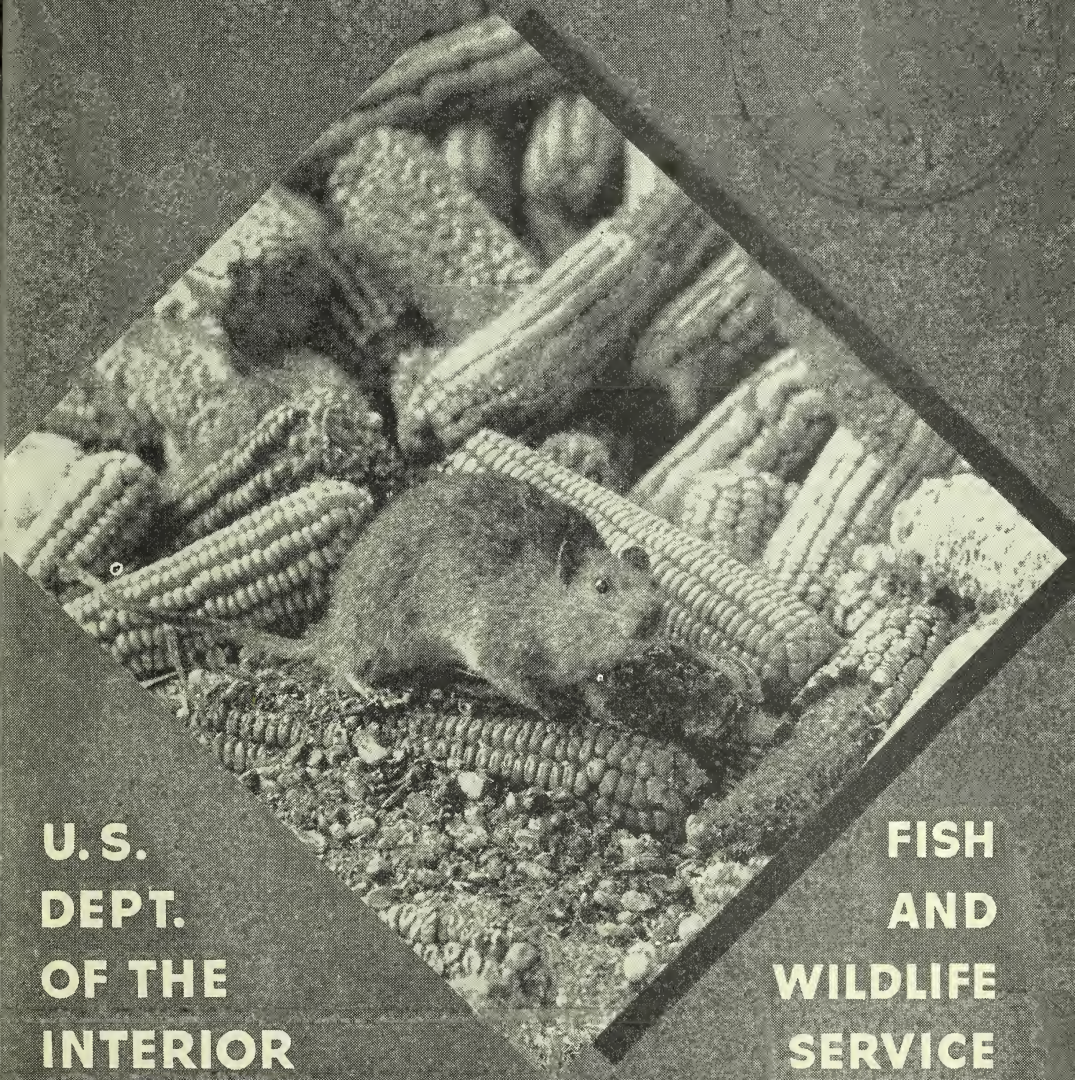
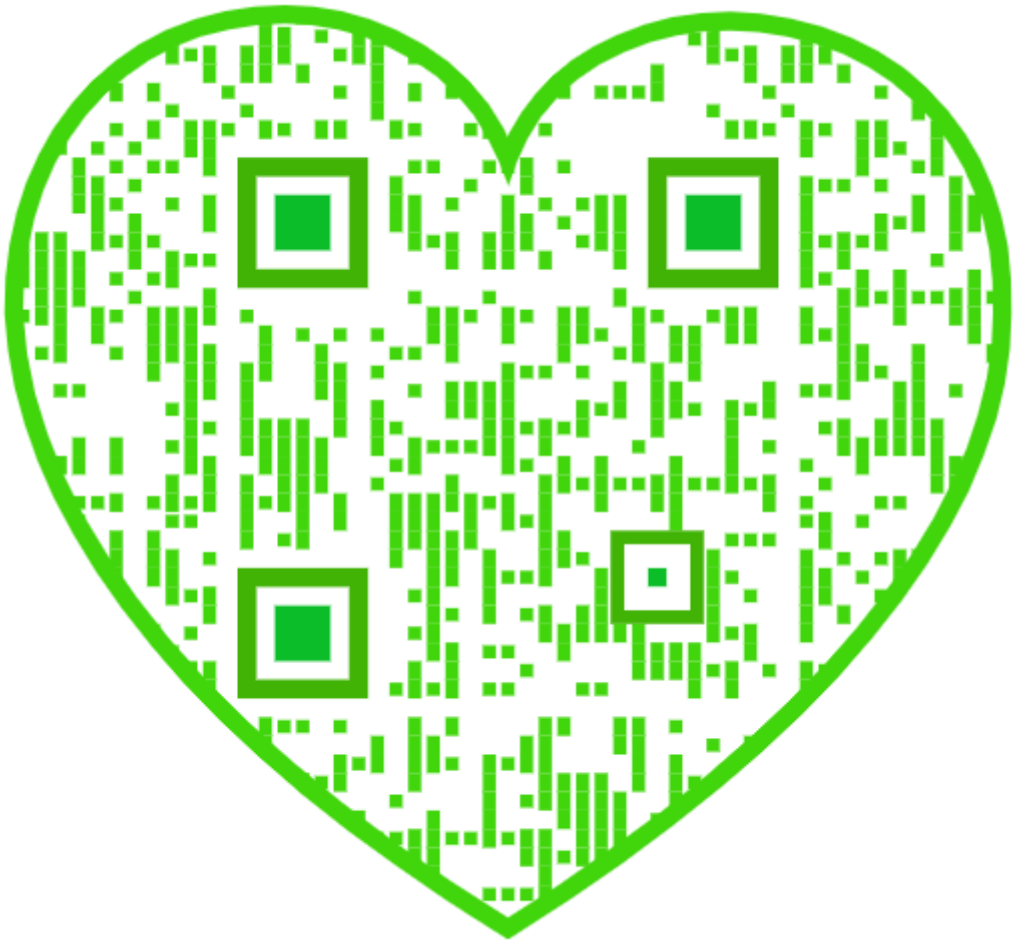
RAT CONTROL



U.S. DEPT. OF THE INTERIOR

FISH AND WILDLIFE SERVICE

CONSERVATION BULLETIN NO. 8



UNITED STATES DEPARTMENT OF THE INTERIOR
Harold L. Ickes, Secretary

FISH AND WILDLIFE SERVICE
Ira N. Gabrielson, Director

Conservation Bulletin No. 8

RAT CONTROL

BY

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RATS are probably decreasing in numbers in some localities in the United States, although their decrease is only beginning to be apparent. The chief factors responsible for any diminution are present-day sanitary requirements and modern building construction, which make food and shelter increasingly difficult for rats to find; a better understanding generally of their relation to human economy; and a national urge against all unnecessary waste. Furthermore, as facts relating to the spread of communicable diseases have become better known, more general interest in rat control has been stimulated and information regarding the development of more effective methods of destroying rats has been widely distributed. In addition, individuals and organizations are showing a greater willingness to cooperate with scientific and governmental agencies in waging a general and sustained warfare against these destructive rodents. Despite all that has been done to combat the rat, however, this pest is still mankind's greatest enemy in the animal world. This bulletin describes modern methods of excluding and destroying the pest.

RAT CONTROL

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PERMANENT EXCLUSION OF RATS

THE PERMANENT EXCLUSION of rats involves primarily the proper construction, repair, and upkeep of buildings and keeping the premises in sanitary condition. Rats require both food and shelter, and they cannot exist where either is lacking. Rat infestation of premises can usually be traced to some condition favorable to the animals, and the removal of this condition generally means permanent reduction of rat damage.

RATPROOFING [1]

Most modern buildings and many older ones are constructed ratproof or could be made so at relatively small cost. Owners of large warehouses, food depots, and other buildings in which supplies are stored have found that the cost of ratproofing, even if considerable, is slight compared with the resulting protection from loss and that in the long run it is the cheapest form of "rat insurance" (fig. 1). Wherever it can be accomplished at a reasonable expenditure, ratproofing is recommended as the best and most permanent means of ridding the premises of rats.

In a building with brick, stone, or concrete foundations it is first necessary to search thoroughly for all places where rats might enter. Small openings around pipes and small cracks due to careless workmanship, sometimes in places where the exterior of the wall is hidden by porches or adjoining structures, should be closed with metal sheeting or with rich concrete. Basement windows and other large openings should be covered with strong and durable screening, such as standard 8-mesh galvanized hardware cloth, which will keep out

[1] See Farmers' Bulletin 1638, Ratproofing buildings and premises.

NOTE.—This bulletin supersedes Farmers' Bulletin 1533, Rat Control, issued in 1927 by the U. S. Department of Agriculture—a contribution of the Bureau of Biological Survey, which was consolidated in 1940 with the Bureau of Fisheries to form the Fish and Wildlife Service, U. S. Department of the Interior.

flies as well as rats and mice. Ventilators and sewer openings should be provided with gratings, and doors that are likely to be left open at night should be equipped with self-closing devices. Below the gratings for sewer openings there should be a shield of smooth rich cement or rustproof metal.

Buildings without ratproof foundation walls should be elevated 18 inches or more and kept open on all sides and free from all accumulations underneath. Cornerибs, granaries, and similar food-storage

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Figure 1.—**In a ratproof public market there is no destruction or contamination of food by rats, and thus the produce on display and in storage is protected and the public health safeguarded.**

buildings also should be equipped with metal rat guards at the tops of supporting columns or entirely enclosed with wire mesh. Some buildings, particularly barns and other open-type farm structures, cannot be protected economically, but in most cases rats can be kept under control by eliminating their harbors as far as possible and by persistently destroying the animals themselves. Further information relating to ratproof construction and repair will be furnished on request by the Fish and Wildlife Service, United States Department of the Interior, Washington, D. C.

REMOVAL OF SHELTER

To remove places where rats, without fear of molestation, make their homes and raise their families is one of the most important

problems in control. The surest way to permanent riddance is the removal of favorable harbors, for a rat will not remain where safe and comfortable shelter is not available.

The most common harbors are dead spaces within double walls and beneath floors. Considerable effort is usually required to abolish these shelters, but it is often essential to permanent control. Double walls may be shut off from rats by stopping the openings left between the studs and floor joists just above the sill. In new structures these

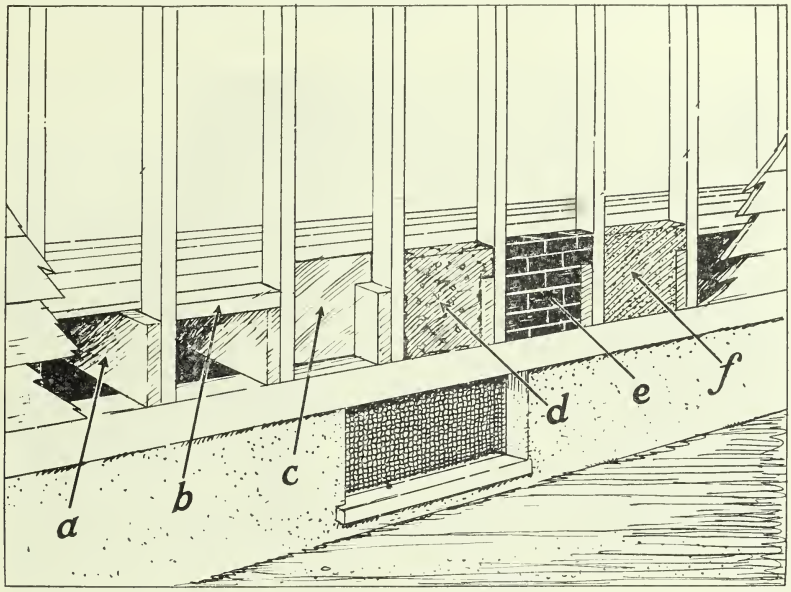

Figure 2.—**Methods of excluding rats from double walls: A common type of building construction (*a*) with open space between floor joists, giving rats free access to double walls; wooden 2-by-4 stops (*b*) are sometimes employed, but as these have an important function in fire control, noncombustible material should be used (wood is permissible, however, in upper floors); in old buildings galvanized sheet metal (*c*) may be cut to fit and nailed into place between studs, joists, floor, and sill; in buildings under construction noncombustible stops of cement and cinders (*d*) or broken bricks (*e*) are inadvisable, but preferably a good grade of rich cement (*f*) is recommended.**

spaces should be filled to a height of 4 inches above the floor with a good grade of rich cement (fig. 2).

In old buildings walls may be stopped by fitting sheet metal between the joists and nailing it to the sill. Sealing hollow walls by these means is commonly called fire-stopping. It is now required by the building regulations of many cities and is of great value not only in eliminating rat harbors but also in retarding the spread of fire and in improving insulation against heat and cold.

Wooden floors in buildings without basements, particularly on farms, provide free shelter for rats. Where possible these floors should be replaced by concrete, with retaining walls extending 2 feet underground to prevent burrowing under the floor from the outside.

Other common shelters are those provided by stored produce and supplies, lumber piles, and accumulations of trash and refuse (fig. 3). Waste should be disposed of promptly and stored materials elevated on platforms at least 18 inches off the ground or floor. Thorough cleanliness and orderliness discourage the presence of rats and force them to seek other quarters. The entire removal of harbors is not

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Figure 3.—**Untidy premises in a thickly settled district invite community rat infestation. In such places trash should be disposed of and useful materials elevated on platforms.**

always possible, but when this condition is approached the problem of riddance becomes simpler.

CUTTING OFF THE FOOD SUPPLY

Food is an important factor in all rat infestation. Food shortage limits the number of rats that premises will maintain and reduces breeding. Hunger also renders poisoning and trapping more effective. The important means of abolishing the food supply are to store foodstuffs in ratproof buildings, rooms, or containers and to dispose of waste and garbage in tightly covered receptables (fig. 4).

A sufficient number of garbage cans of proper size should be used to hold all the refuse and garbage yet have the lids fit tightly. Care should be taken in putting the garbage into the cans to avoid dropping

any on the outside. Cleanliness and orderliness in the storage of food and the disposal of garbage are important factors in the control of rats.

DETERRENTS

Rats appear to have a marked aversion for certain odors and seem consistently to avoid them. This suggests the use of deterrents under certain conditions. In seed warehouses and similar structures where sacked grain is stored, a liberal application of flake naphthalene scattered on the floor about the sacked grain and over the bags has been found objectionable to rats and will keep them away, and it does not damage the seed. Because of its odor, the use of naphthalene is

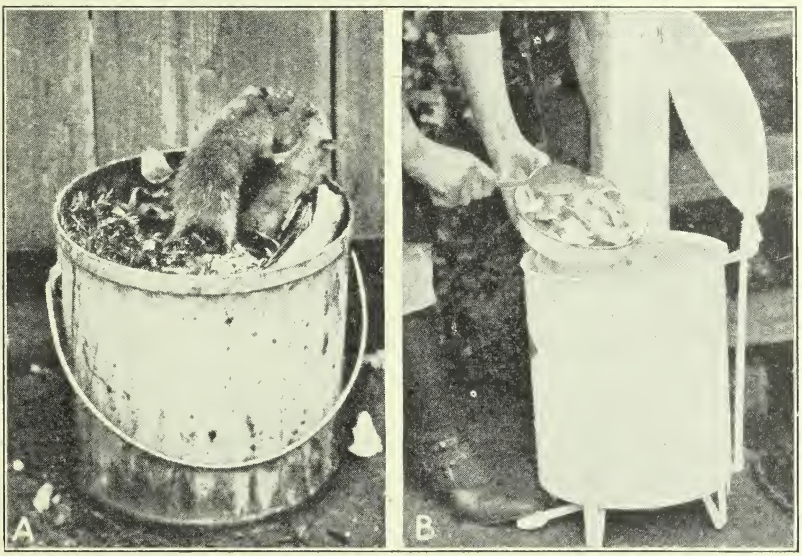

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Figure 4.—**The uncovered garbage can, A, is one of the most common sources of food for rats. An automatic cover, B, is convenient.**

not recommended in places where food and foodstuffs are stored, unless the nature of the material is such that it can be thoroughly deodorized by airing before use.

Many other compounds are said to be objectionable to rats, chiefly creosote, carbolic acid, and other coal- and wood-tar derivatives, kerosene, and oils of peppermint and wintergreen.

Compounds that rats avoid may often be used where an odorous preparation would be objectionable. Among these are powdered sulfur, lime, lye, and compounds of copper. Commercial dry lime-sulfur mixture has been used successfully in protecting stored grains, such as corn. Strong cayenne pepper, placed on the floor along the walls of a room or in burrows, has been found to repel rats.

Deterrents may often be used to advantage to prevent reoccupation of old burrows and other rat habitations after a successful campaign of destruction.

DESTRUCTION OF RATS

Although measures for the permanent riddance of rats should be taken wherever practicable, they usually must be combined with destruction of the animals, and in many places continual killing is the only practical method of control. Numerous materials and contrivances are designed for rat destruction, but relatively few of them have proved to be of outstanding usefulness. Employment of methods of destruction adapted to certain local conditions will simplify control.

POISONING

The most efficient known means of destroying rats, and the one most generally recommended, is poisoning. The chief objections to its use are its danger to human beings and domestic animals and the possibility that rats taking it will die in inaccessible places, where their decomposing bodies may cause obnoxious odors. The first objection can be met by using as mild a poison as possible and by exercising proper care in exposing it; the second may be practically overcome by using a slow-acting poison.

Success in poisoning depends largely upon the baits used and the methods of mixing and distributing them. The all-important requirement is to set out food that the rats will eat. Experience has taught that the kind of poison used is generally of less importance than the bait. Usually it is almost as difficult to get the animals to eat unpoisoned foods as those that are properly prepared and poisoned. For this reason, regardless of the kind of poison used, it is important that care be exercised in selecting, mixing, and distributing baits.

BARIUM CARBONATE

Barium carbonate (precipitated) is a heavy, white, mineral salt, mildly poisonous, tasteless, odorless, slow in action, and inexpensive, and all these characteristics contribute to its value as a rat poison. It is also effective and dependable when properly set out, and it is therefore recommended wherever it can be used with safety. An objection to barium carbonate is that baits containing it cannot be distributed freely without endangering other animals. Although comparatively mild and far less dangerous than most of the poisons commonly used in commercial rat baits, it is nevertheless fatal to chickens, dogs, cats, and larger animals if eaten in sufficient quantity.

Barium carbonate can be used with safety, however, even in poultry runs if sufficient care is taken to expose it in such inaccessible

places as behind or under boxes or behind boards leaned lengthwise against a wall to form a natural runway. In such cases the bait should be either in the form of meal or so wet that the rat cannot drag it from cover.

The following directions for using barium carbonate have been carefully worked out and found to produce the best results:

KINDS OF BAIT

A variety of baits used separately gives the rat a choice of foods and increases the chances of the bait being taken. Baits should be fresh and of good quality. One kind each of the following classes of food mixed separately with barium carbonate is recommended:

Cereals, as fresh bread, finely ground dried bread crumbs, jelly roll, breakfast cereals, corn meal, and rolled oats moistened with a vegetable or nut oil, using 1 ounce of oil to 1 pound of cereal.

Meats or fish, as hamburger, halibut, salmon, or mackerel, or desiccated egg.

Fruits and vegetables, as apples, melons, tomatoes, carrots, avocados, and bananas.

HOW TO PREPARE BAITS

The powdered barium carbonate should be thoroughly worked into the soft cereal or ground meat with the hands or with a spoon, in the proportion of 1 part of the poison to 5 of the selected food. Water or a vegetable oil should be added when necessary to make the baits moist. Barium carbonate baits moistened to the consistency of soft mush are most acceptable to rats.

Barium carbonate should be sifted over sliced fruit and vegetable baits and rubbed well into them with a knife. The slices should be moistened, if necessary, should be thin, and must be poisoned in the 1 to 5 ratio as nearly as possible.

HOW TO DISTRIBUTE BAITS

A teaspoonful of the prepared mixture is a sufficient quantity for the average rat bait. Put the baits in places frequented by rats, preferably where they have been observed to feed. When necessary to protect baits, a convenient and successful method of exposing them is to wrap teaspoonful quantities in small squares of newspaper or place them in small paper sacks and close them by twisting the tops. When a variety of baits is used, wrap each kind separately and expose one of each kind in groups, or in sequence, to give the rats a choice. In public places, where there is a possibility of their being disturbed, baits should be wrapped and the packages labeled POISON.

It is important that a sufficient number of baits be distributed at one time to provide an ample supply for every rat on the premises;

otherwise the resulting mortality will arouse the suspicion of the rats that are unharmed and will render subsequent baiting less successful. It is much better to put out an excess of bait than not enough.

Baits should be distributed in the evening, so they will be fresh when the rats are feeding, and those uneaten should be picked up the following morning and destroyed, as stale baits usually are unattractive to rats and as the acids resulting from souring food render barium carbonate bitter and objectionable.

If the poisoning has been carefully carried out, a high mortality may be expected. Should the operations not be wholly successful, it is well to wait 2 weeks or more before repeating with other baits and poisons.

PREBAITING IN DIFFICULT CASES

In stubborn cases, or when one is willing to go to additional trouble to increase the chances of success, prebaiting is recommended. This consists of exposing fresh material, prepared precisely like the poisoned baits except for omitting the poison. About half the amount of this material should be used in prebaiting spots that will be used later in baiting with poison. If these are taken freely the first night, poisoned food should be substituted after an interval of 1 or 2 nights. Otherwise, clean baits should be exposed at 2- or 3-day intervals (being picked up in each case the following morning), until the rats take them without hesitation. Then poisoned food will doubtless be taken the following night, and the result should be that most of the rats will be killed.

Caution.—Although barium carbonate is not one of the most toxic poisons, the danger from accidents must be emphasized. *Keep it out of reach of children and irresponsible persons and from domestic animals and fowls.*

Antidote.—Give an emetic consisting of either mustard or salt dissolved in warm water, or induce vomiting by inserting the finger in the back of the throat. Follow vomiting with a liberal dose of Epsom or Glauber salts.

RED SQUILL

Squill is a perennial bulb that grows wild along the coast of the Mediterranean Sea. The bulbs are pear shaped (fig. 5), usually 3 to 6 inches or more in diameter, and weigh up to 12 pounds. There are two commercial varieties, the white, used in medicine as a heart tonic, emetic, diuretic, and nauseant expectorant; and the red, which in addition has toxic properties of use as a rat poison. Squill contains calcium-oxalate crystals, which, on coming in contact with the skin, cause a sensation similar to that of a nettle sting.

Red squill as a rat poison has the distinct advantage of being relatively harmless to human beings and domestic animals. This is

due in part to its acrid taste, which is highly objectionable to most animals, and also to the fact that it usually acts as an emetic when taken in dangerous quantities. It is taken fairly well by rats, however, and since these animals do not vomit, this poison approaches the unique position of being specific for them. Reports are occasionally received that chickens, cats, or dogs have died after eating red-squill baits, but investigations have rarely shown squill to be the cause. Active preparations of the poison are therefore of particular value where the use of more toxic products would be inadvisable.

The chief objection to squill is that its toxicity may vary widely because of conditions under which the bulb is grown, harvested, and

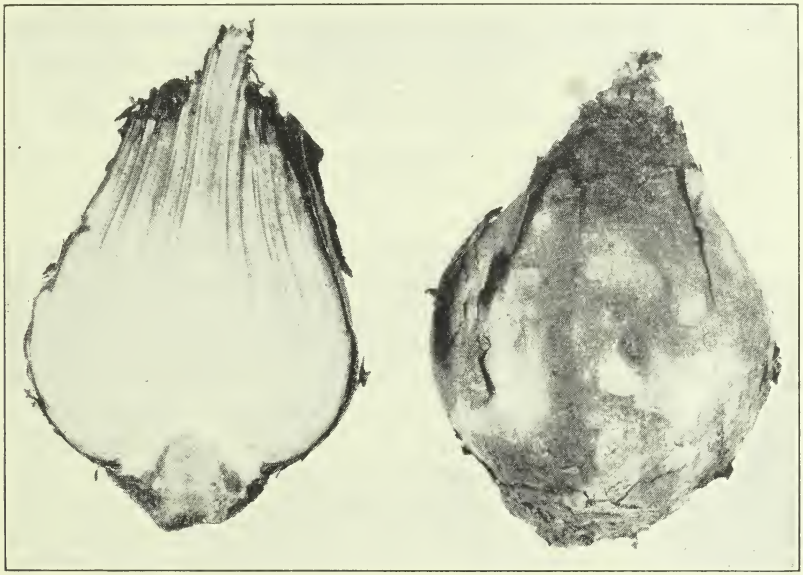

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Figure 5.—**Red-squill bulb (*Urginea maritima*).**

processed, so that commercial red-squill rat poisons are apt to lack uniform potency. It is therefore important that individuals, as well as dealers, purchase their supplies from manufacturers who will guarantee the toxicity of their products.

Red squill is marketed in both liquid and powdered form, and either one may be effective. The powder, as a rule, is more easily used, is less expensive, and keeps better; it can also be mixed more readily with a wide variety of baits.

DIRECTIONS FOR PREPARING RED-SQUILL BAITS

Because of the variability of the commercial product, it is necessary in preparing baits to vary the proportion of red squill to the foods used. Directions for use accompanying red-squill products pur-

chased should serve as a guide in this respect. The proportions here given apply to the more toxic red-squill powders now on the American market. A variety of three or more kinds of baits greatly increases the chances for a thorough clean-up on any premises, and separate baits from three of the following classes should be carefully prepared:

Fish.—Fresh fish ground in a meat chopper is one of the most attractive baits for rats. If fresh fish is not available, a cheap grade of canned salmon, canned mackerel, or sardines in oil may be used. Mix 1.6 ounces of powdered red squill with a little water to form a thin paste free of lumps, add to 1 pound of fish, and mix thoroughly.

Meat.—Mix 1.6 ounces of powdered red squill with a little water to form a thin paste free of lumps, add to 1 pound of fresh ground meat, and mix thoroughly. Unseasoned hamburg steak is most commonly used.

Cereals.—Mix together, dry, 1.6 ounces of powdered red squill to 1 pound of cereal meal, such as oatmeal, graham flour, corn meal, or bran. Add 1 pint of sweet milk or water and stir to a mushy consistency.

Fruits and vegetables.—Using a pepper shaker, dust powdered red squill over thin slices of fresh fruit or vegetables and stir or shake as the powder is applied to insure even distribution. A small muskmelon, for example, should be cut into about 16 slices and each slice cut into 3 sections. This will require about 1½ ounces of powdered squill and will make 48 baits. Two medium-sized tomatoes, sweetpotatoes, or bananas, each cut into about 16 sections, may be similarly used for each ounce of squill powder.

Liquid red squill should be used only with a dry bait capable of absorbing about double its weight of liquid. Cut ½ pound of stale bread (not moldy) into ½-inch cubes, place in a clean dish, and pour 1 pint of liquid red squill over them, mixing gently with a spoon. Use several cubes for each bait.

DISTRIBUTION OF SQUILL BAITS

In exposing squill the directions for distributing barium-carbonate baits, as given on page 7, may be followed to advantage in a general way. Barium carbonate, being tasteless, may often be repeatedly used with success, whereas squill has a taste that, although not objectionable to rats, would probably be associated by them with the ill effects suffered from former nearly fatal doses. It is therefore desirable for best results that prebaiting be practiced and that a sufficient quantity be exposed on a premises at one time to dispose of all rats present.

Although barium-carbonate baits must be moistened with water to overcome the objectionable feature of a dry powder in the mouth,

squill is effective when mixed with a dry cereal meal, and should keep in good condition for a long time. A bait that keeps well may be left exposed for an indefinite period in poison caches, where it will be of value in protecting premises from rats and mice that may from to time find their way into buildings temporarily vacated. Although squill usually has not been found injurious to most kinds of domestic animals, it is recommended that baits be placed where other animals will not have access to them.

OTHER POISONS

Relatively mild rat poisons, as barium carbonate or squill, are usually effective and are recommended in most cases. Sometimes, however, some of the more active poisons are necessary for complete success. In using a highly poisonous preparation additional care is necessary to prevent accident. Of the many poisons that will, when properly prepared, destroy rats, phosphorus, arsenic, strychnine, and thallium are of outstanding usefulness and form the basis of the majority of commercial rat poisons.

Phosphorus is used extensively in commercial rat poisons. It has distinctive taste, odor, and luminous properties by which it may be readily identified but to which rats apparently do not object. Though undoubtedly effective against rats, phosphorus is dangerously poisonous, and in the absence of a good antidote is considered unsafe for general use. Fire hazard connected with the use of commercial pastes containing this element probably exists only when the particles are greater than colloidal in size, and the paste is not thoroughly mixed.

Powdered white arsenic, or arsenious oxide, is widely used in commercial preparations for the destruction of rats. It is practically tasteless and odorless and is usually taken readily when mixed with attractive baits in the proportion of about 1 part poison to 20 parts food, although a slight grittiness detracts somewhat from its palatability. A finely pulverized, nongritty form of white arsenic has recently been demonstrated to be of greatly increased toxicity. Arsenic is somewhat variable in its effect upon rats, which, on surviving a first dose, will refuse subsequent baitings. It is highly toxic when taken internally and somewhat dangerous through local external application. Great care must be exercised in its use.

Strychnine is extremely poisonous. It has a bitter taste that must be disguised if it is to be used successfully as a rat poison. Its rapid action also increases the chances that the animals may die in walls and other inaccessible places in buildings. Strychnine is therefore not recommended for use in poisoning rats in buildings, but has been found useful under certain conditions in the open, particularly in city dumps.

Thallium is a heavy metal similar to lead in physical properties and is now being extensively sold as thallium sulfate both in Europe and America for use as a rat poison. It is a cumulative and powerful poison, slow acting, and certain in its results. It also has no objectionable taste or odor, so that were it not for the grave danger attending its use it would make an ideal rat poison. Without distinctive taste or smell to identify it, and being fairly readily absorbed through the skin, thallium sulfate is most dangerous to human beings and domestic animals and should be used only with the utmost caution.

ATTRACTANTS AND STABLE BAITS

An effort has been made to find some lure that would induce a rat to come to a bait to feed. Volatile oils having a pleasant odor have been tested but the only attractants that have justified their use have been the essential oils of foodstuffs that rats like or the foods themselves. The following have been successfully used: Peanut butter, dairy butter, ground bacon, bacon oil, powdered milk, hamburger, corn oil, cream cheese, nut oil (by-product of the nut-roasting industry), fresh meat or vegetable or fruit products, blackstrap molasses, brewer's yeast, and cottonseed oil.

These attractants can be blended with bait materials in sufficient quantity to lure the rats and arouse their appetite enough to induce them to eat. The basic bait materials suggested are ground dried bread (not moldy), corn meal, and rolled oats of the grade used for feeding poultry. The bread is prepared by breaking loaves up well to prevent molding, or by spreading the sliced bread out well to dry thoroughly, or by drying it with heat or by use of a fan. The dried bread should be passed through a meat grinder set to grind finely. If kept in a dry place, it will remain acceptable to rats for weeks. This bait can best be used in buildings in parts of the country where the humidity is not too high. It can be used alone or blended with an equal or lesser proportion of corn meal. Cracked wheat may be employed in baits to be used on farms.

The use of the fresh materials treated with toxic chemicals has been considered in the discussions of the various poisons. There also is need for some baits that can be prepared in quantity and will remain acceptable to rats after long exposure. They may be used in the first baiting, or after the use of fresh baits to deal with the surviving rats, or with stragglers later coming into the treated area.

SUGGESTED BAIT FORMULAS

In preparing baits it is best to mix the poison, in the proportion of the total bait shown in table 1, with the oily constituent in the formulas before blending with the other ingredients.

TABLE 1.—*Quantity of poison to use with bait*

Kind of poison	Poison	Bait
	Ounces	*Pounds*
Red squill	16	9
Thallium sulfate	1	4
Micronized arsenic trioxide	1	2
Barium carbonate	16	5
Zinc phosphide	1	6

Formula No. 1

	Pounds
Ground bread crumbs	8
Ground bacon	1

After grinding the bacon stir in the selected powdered poison for 10 minutes to insure a thorough mixture; then add the bread crumbs, thoroughly mixing for 5 minutes, in a power mixer if available. This bait should be used within a few days after preparation.

Formula No. 2

	Pounds
Ground bread crumbs	35
Peanut butter	5
Blackstrap molasses	5

Add the selected powdered poison to the peanut butter and stir into a mixture of the other ingredients for 10 minutes or more. This bait will remain acceptable to rats for several weeks.

Formula No. 3

	Pounds
Ground bread crumbs	40
Peanut butter	4
Cottonseed oil	1

Add the selected powdered poison to the oil and stir into a mixture of the other ingredients for 10 minutes or more. This is a permanent bait that can be kept for a long time if stored in a tightly closed container.

Formula No. 4

Ground bread crumbs	10 pounds
Freshly ground hamburger	10 pounds
Glycerine	10 ounces

To prepare as a fresh bait, stir the desired powdered poison into the hamburger, then add to a thorough mixture of the other ingredients, stirring for 10 minutes or more.

To prepare as a dry permanent bait use any of the poisons, except barium carbonate and zinc phosphide, and after thoroughly mixing let it dry completely in an oven gently heated. Put aside in a tight container in a dry place. Before using moisten with a little cold water.

Formula No. 5

Ground bread crumbs	4 pounds
Cream cheese	1 pound
Mineral oil	1 ounce

Add the selected powdered poison to the oil and stir thoroughly into a mixture of the other ingredients, or first mix well the poison with the cheese, stirring this into the mixture of bread crumbs and oil. This bait will keep 2 months or more, and though it may become rancid, it will remain acceptable to rats.

Rolled oats of the grade used for feeding poultry may be substituted for bread crumbs in any of these formulas, though they are not so attractive to rats, or a mixture of bread crumbs and corn meal may be used.

OTHER BAIT MATERIALS

Often on farms or where rats for some time have been eating stored feeds, one of these can well be employed as a bait material. When poison is mixed with this bait and it is exposed where rats can get it, the clean feed should, whenever possible, be removed from reach or access to it shut off. In follow-up work the operator must seek the type of bait material that will be most acceptable under prevailing conditions.

EXPOSURE OF BAITS

> Only red-squill rat baits should be used by the public; those prepared with other poisons should be exposed only by persons experienced in handling highly toxic materials. In using poison baits operators should not allow the toxic agent to remain long on the bare hands, as absorption through the skin may occur. This is particularly true when any of the poisons are used in solution.

Great care should be exercised in selecting baiting spots. Where bait can be exposed without its being reached by pets or children, put 1 tablespoonful at a place along rat runs. The number of placements should be in proportion to the degree of infestation, and in this respect much depends upon the judgment of the operator. It is better to expose several small baits than a few large ones. When different kinds are used, they should be alternated along the bait line.

In situations where poisoned baits should be covered, a special cubical box (fig. 6) may be used. It is made of 1- by 10-inch and 1- by 12-inch boards, cut as shown. It has three openings: at the lower left corner in front, and at the upper left and lower right corners in the rear. Each opening is 2 inches wide by 2½ inches high. A cleat, ¼ by ¼ by 10 inches long, is nailed or screwed to the floor diagonally across the corner below the upper hole so as to enclose a space within which to place the bait.

A 1- by 3-inch slat is screwed horizontally to the outside of the box across a side that does not have openings, the ends projecting to permit fastening securely with screws to some stationary object. The box may be placed on a wall in a commercial building or garage, by

the side of an incinerator, in a backyard, along a fence, or by piles of building or stored materials.

When the box is in place, the bait can be inserted through the upper opening at the rear, or at the hole in front. Not more than 3 tablespoonfuls at a time should be used. When it is advisable to prebait for a few days without poison to induce rats to come into the box to feed, the same kind of material should be used as for final baiting. Information concerning the properties of toxic agents is summarized for convenient reference in table 2.

In making a thin starch paste for applying some of these poisons to grain baits, ½ ounce of dry-gloss starch should be mixed in ¼ pint

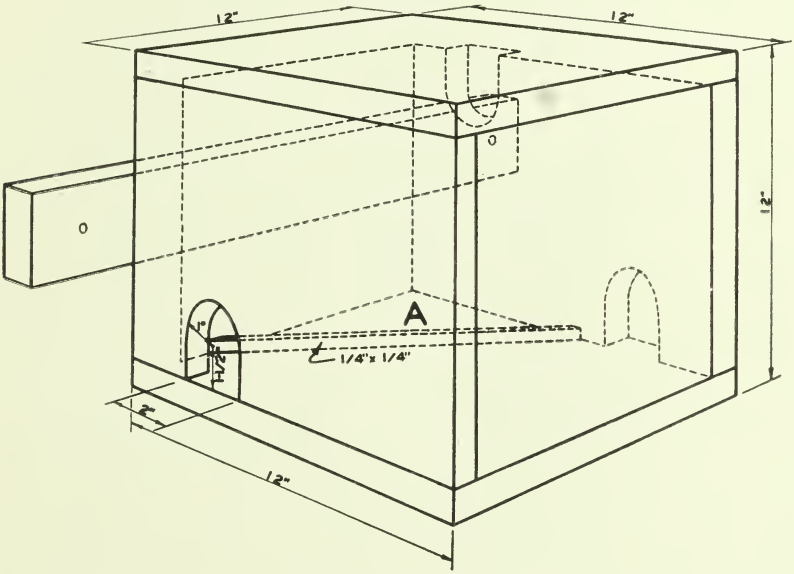

Figure 6.—**A 12-inch cubical box in which to expose poisoned bait. The bait should be in the space "A."**

of cold water, and then stirred into 1 pint of boiling water. The mixture should be boiled and stirred to a smooth paste, free of lumps. Poisons soluble in water may be dissolved in boiling water before the starch is added.

FUMIGATION

The fumigation of burrows and other harbors is a simple and highly effective method of destroying rats and is recommended wherever a sufficient concentration of gas can be obtained readily. Unfortunately, however, rats are found in many places that can not be reached with gas, so that this method must usually be combined with poisoning or other methods of destruction.

TABLE 2.—*Solubility and toxicity of poisons for rat control and the proportions to use with bait material*

Kind	Form	Liquid required to dissolve 1 ounce		Lethal dose		Proportions for 90 percent efficiency	
		Cold water	Other	Mg./kg.[1]	Killing time	Poison	Bait
					Hours	*Ounces*	*Pounds*
Arsenic trioxide	U. S. P., 200 mesh	3 quart [2]		100	24	16	32
Sodium arsenite	Commercial powder	(3)		130	24	1	[4] 8
Barium carbonate	Technical powder	(5)	Dilute ammonium chloride [3]	750	24	16	4
Red squill	Commercial powder	(6)		400–600	24–120	16	9
Do	do	(6)		600–800	24–120	16	7
Strychnine alkaloid	do	48 gallons	Alcohol (4½ quart) or chloroform (⅓ pint).	10	½	1	10
Thallium sulfate	do	567 cubic centimeter [7]		25	72	1	[8] 4
Zinc phosphide	Commercial powder (fine)	(6)		25	6	1	[9] 6

[1] Milligrams per kilogram of body weight.
[2] Arsenic trioxide in hot water, 1 pint.
[3] Very soluble.
[4] Approximate weight; use 1 gallon of water.
[5] Only slightly soluble.
[6] Insoluble.
[7] Thallium sulfate in hot water, 156 cubic centimeters.
[8] For mouse control, 6 pounds.
[9] For mouse control, 10 pounds.

In certain buildings, where insect pests, as well as rats or mice, are a serious problem, as in flour mills, grain elevators, packing houses, and even in stores and dwellings of certain types, the fumigation of the entire building with a poisonous gas becomes the most practicable method of pest riddance. This type of control, however, on account of the danger involved, should be intrusted only to men experienced in handling fumigants.[2] Rat burrows or harbors, on the other hand, can be gassed by any intelligent person without danger of accident, if directions are carefully followed.

CALCIUM CYANIDE

Of the many chemicals commonly employed for destroying rats in their harbors, calcium-cyanide dust is of outstanding usefulness. Calcium cyanide is a compound that rapidly gives off hydrocyanic, or prussic, acid gas when acted upon by moisture in the air. This gas is extremely poisonous and in sufficient concentration is destructive to most animal life. It has come into prominence in connection with control operations directed against various rodent and insect pests, and the dust form of the compound has proved a highly effective agent in favorable situations for local extermination of rats.

Calcium-cyanide dust may be used to advantage in destroying rats in open burrows in fields, along ditch banks and levees, in city dumps and sanitary fills, around the exterior of buildings, under sidewalks, pavements, and tight floors (fig. 7), in lumber piles, rubbish, and other accumulations, in walls and hedgerows, in corncribs, and sometimes in hay or straw stacks. It is particularly suited for use on farms and poultry plants and around city dumps.

The dust is used most effectively by forcing it into rat burrows or other harbors by means of a portable dusting pump or duster with a flexible hose attached. A few strokes of the pump will fill most burrows with the smokelike dust, which will emerge from all connecting openings and thus indicate the extent of the system. All openings through which the dust escapes should be closed with earth, sod, or other material.

In double walls of farm buildings, lumber piles, or corncribs, where the escape of the gas cannot well be prevented, it is necessary to use much more dust than in an air-tight burrow. Dusting should be done on a still day, so that drafts or air currents will not quickly carry the gas away.

In dusting corncribs some of the powder should be forced into the corn about midway between the top and bottom of the crib and then should be pumped in all around near the bottom at 3- or 4-foot intervals. A short length of iron pipe driven into the corn that is to

[2] Information on the fumigation of buildings is contained in Farmers' Bulletin 1670, Hydrocyanic acid gas as a fumigant, issued by the Department of Agriculture.

be dusted will aid in getting the chemical well into the center of larger cribs (fig. 8.)

The use of gas in haymows is less practicable, because the quantity of dust required is usually out of proportion to the results obtained

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Figure 7.—**Fumigating rat burrows under a cement floor with calcium-cyanide dust.**

except in haymows carrying old hay that is packed and has well-defined burrows.

There is little danger attending the use of calcium-cyanide dust in corn or other edible products, because the gas becomes entirely dissipated in a few hours and the residue is nonpoisonous. To be entirely safe, however, the feed should not be used for several days after dusting.

There are several types of dusting pumps on the market suitable for use in forcing calcium-cyanide dust into rat harbors, but a foot-pump duster, similar to a bicycle pump but of greater diameter, most nearly meets requirements in poultry plants and on farms, city dumps, and other large premises. This type of duster will enable the operator to force the dust into the extremes of rat systems impossible to reach with a less powerful pump. For use around the exteriors of residences, however, and in other places where only burrows in

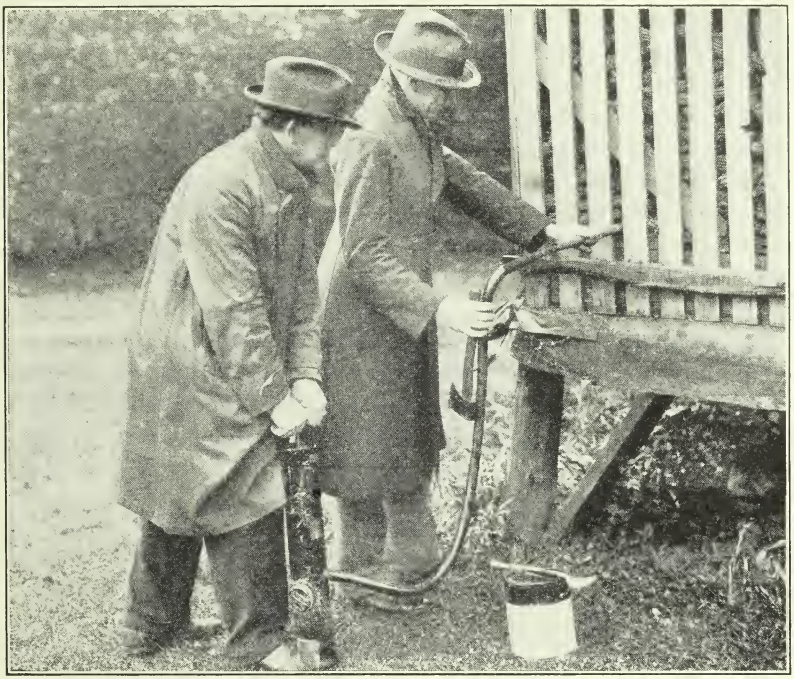

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***Figure 8.*—An iron pipe driven into the corn aids in getting the fumigants well into the center of large cribs.**

the ground are involved, a small inexpensive hand-pump duster will give satisfactory results. Dust pumps should be lubricated according to the instructions of the manufacturer and always be emptied before being put away.

Caution.—All cyanide preparations and the hydrocyanic-acid gas given off by them are extremely poisonous and should be handled with the utmost care. This poison should not be used in enclosed buildings or transferred from the container to the duster indoors. Avoid breathing the gas given off, and always wash the hands after handling the poison. The dust rapidly deteriorates upon exposure to air, so that the cans should be quickly and tightly closed after removing part of

the contents. *Store in a safe place away from the house and out of reach of children, irresponsible persons, and livestock.*

Antidotes.—For poisoning from calcium-cyanide fumes, breathe fresh air and slowly inhale fumes of amyl nitrite. This drug is available in glass ampuls encased in cloth. To use, leave in cloth, break glass, and hold near nose of patient 15 to 30 seconds every 3 minutes rather than continuously. Not more than one should be used before the physician arrives. If calcium cyanide has been swallowed, the stomach should be immediately emptied with a stomach pump, as emetics often fail. This can be done while the patient is inhaling the amyl nitrite. Artificial respiration should be administered if breathing becomes too weak.

When the physician arrives, he may administer a combination of sodium nitrite and sodium thiosulphate. The fatal action from cyanide poisoning may be rapid, but since cyanosis or unconsciousness may continue for 3 hours or more, antidotal treatments should be applied as long as the victim's heart beats.

OTHER FUMIGANTS

Exhaust gases from an automobile, tractor, or other gasoline engine (carbon monoxide) may be successfully used in destroying rats in their burrows, beneath floors, and in other reasonably tight enclosed places. The exhaust is directed into the rat burrow by means of a hose, and the entrance around the hose and all connection entrances through which the gas escapes are sealed with damp earth. The carbureter is adjusted to obtain a rich mixture and the engine allowed to run at moderate speed for 10 minutes or longer.

Carbon bisulfide is only fairly effective in destroying rats, but under favorable conditions it may be used in fields or in holes in dirt floors in chicken houses, cellars, and similar places. The gas is more effective in heavy damp soils and during wet weather. A wad of cotton or other absorbent material should be saturated with 1 ounce (about 2 tablespoonfuls) of carbon bisulfide and pushed as far as possible into each burrow entrance or the gas may be forced into burrows by a special type of applicator now marketed by manufacturers of carbon bisulfide. Entrances should then be closed with moist earth to prevent escape of gas. Long forceps are convenient for handling the absorbent materials.

Caution.—Carbon bisulfide is highly inflammable and explosive and should be kept away from fire. As a gas, mixed with air, it may be discharged even by an accidental spark. Since it evaporates rapidly, it should be kept in an air-tight container.

Sulfur dioxide, acetylene, and chlorine are used as rat fumigants and when properly applied all are successful. Sulfur dioxide particularly is widely used in Europe and has the advantage of being the least

dangerous of the three. The difficulties connected with its use, together with its relatively slow action, however, have prevented its becoming popular in the United States.

TRAPPING

Trapping rats is just as effective as poisoning, but it requires more skill and labor. It is recommended where the use of poison seems inadvisable. Careful attention to detail is necessary, as success will depend largely upon the skill and resourcefulness with which the traps are handled.

Although the more complicated traps and devices for catching rats are sometimes useful, the simple and inexpensive snap trap, sometimes called "guillotine," "spring," or "break back," has proved the most effective and consistent rat catcher. There is little choice among standard makes of this style of trap; selection should be governed by apparent strength and durability. The essential part is a very sensitive trigger provided with a hook or some other means of holding the bait fast. Large triggers have the advantage over small ones in providing a greater surface for the rat to step on and in being better adapted for use along walls and narrow runways, places where rats can be trapped successfully without baiting.

To get the best results, the following directions for baiting and setting snap traps should be carefully followed:

KINDS OF BAIT

The selection of baits for trapping is as important as in poisoning. Fresh baits, changed daily, should be used. A variety of baits, such as meat, vegetables, and cereals, on successive traps will usually give better results than only one kind.

One of the best single baits is doughnut. Bread is also good, but both of these must be fresh, for a rat will usually ignore them if they are only a little stale. Among other foods that may be used as alternative baits are raw or cooked meats, bacon, fish, apple, melon, tomato, carrot, and nut meats. These may sometimes be made more attractive by sprinkling rolled oats, corn meal, or powdered milk lightly over the trap. Cheese, although an excellent bait for house mice, is less attractive to rats. Cotton, mixed with moistened rolled oats makes a good carrier. Many lures may be added, as fish oil, rancid cheese, peanut butter, and others previously mentioned.

WHERE TO SET SNAP TRAPS

Rats rely on concealment for protection and avoid open spaces as much as possible. The best place to set traps, therefore, is close to walls, behind objects, in dark corners, or in any place where a rat would run for concealment. Traps should be set in such manner

that the rat in following its natural course will pass directly over the trigger. For example, a trap set along a wall should extend from the wall at right angles, the trigger end close against it. Boards leaned lengthwise against walls form natural runways for rats and provide good places to set traps.

HOW TO SET SNAP TRAPS

Baits should be large and fastened securely to the trigger by means of the trigger hook or tied with thread or fine wire, so that the rat

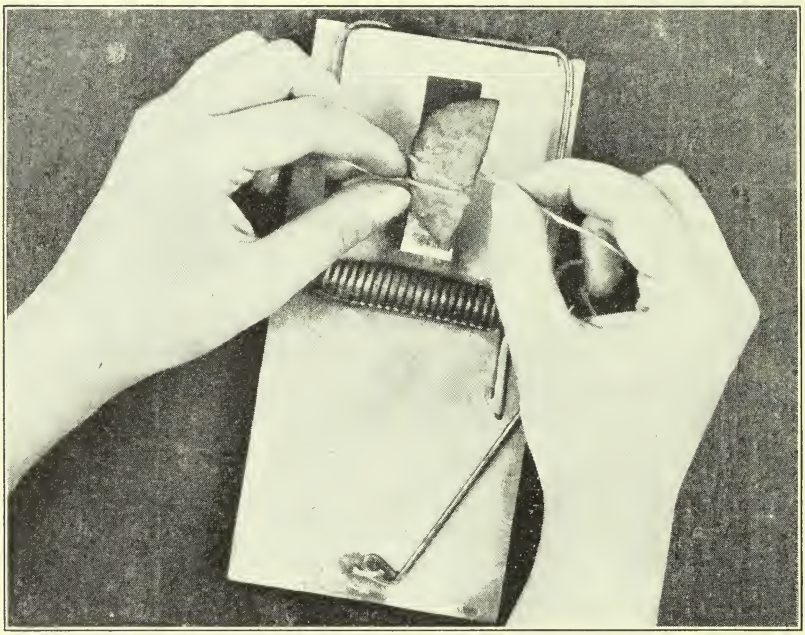

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Figure 9.—**Baits should be tied to trigger so that the rat will be sure to spring the trap.**

will be sure to spring the trap when attempting to remove them (fig. 9). Traps should be set lightly to allow them to spring easily.

After most of the rats have been caught, the others sometimes leave the premises. Often, however, those not frightened away avoid baits and prove difficult to catch. Strategy must be used in outwitting such individuals, and the most successful method is to camouflage the traps. Those set on the ground may be sunk slightly below the surface. A small piece of paper or cloth should then be placed over the trigger end to prevent dirt from getting underneath and clogging the action, and the whole should be lightly covered with fine earth or sawdust. The same method may be employed on hard floors by burying the trap in a shallow pan of meal, sawdust, or grain.

A trap set in this way may be placed in a runway without baiting, or several pieces of bait may be scattered over it. In stubborn cases, food may be exposed on pans of meal until the rats take it readily, after which the traps should be set in the meal. Stones, boxes, or boards will often serve to guide rats along an easy path over a trap.

CAGE TRAPS

Cage traps are in general less efficient than snap traps, although they are capable of catching a large number of rats at one time. Most of them are self setting. The well-known French wire-cage traps will sometimes get desired results, but are not recommended for general use, although they have been improved somewhat with a simple wire catch that holds the trapdoor open until the first rat has entered. Other rats are more likely to venture into the trap after the first one has been caught.

Many other cage traps and similar devices have some merit but no outstanding feature that would warrant describing them here. Cage traps of any kind are less conspicuous when covered with old burlap bags, straw, or other handy material. They should be set in places where rats are accustomed to feed and should be baited as suggested for snap traps.

GENERAL TRAPPING INSTRUCTIONS

An abundance of accessible food for rats makes trapping much more difficult. Before beginning a trapping campaign, put all food out of reach and stop the sources of supply. Plenty of traps should be used. Trying to catch a hundred rats with half a dozen traps will make those not caught suspicious and dishearten the trapper long before the job is half done. A dozen or more for a heavily infested dwelling and 50 to 100 or more for farms and larger buildings are not too many. It is important that a sufficient number be obtained to make the campaign short and decisive. The cost of traps is little compared with the damage caused by rats.

Traps should be kept in good working condition and carefully examined before setting to insure their instant operation. They should be kept reasonably clean, and may be boiled and scraped if they become foul. When trapping is done on a large scale, especially in damp places where metal parts of traps may rust, an occasional dipping in melted paraffin will lengthen their usefulness, cause them to spring more easily, and have a deodorizing effect.

Trapping rats in larger buildings and on farms should be assigned to a man with a natural aptitude for such work. When interest is taken, only slight training is necessary for some men to become proficient in the work, and these should be encouraged to persistent effort.

BLOCKING

Blocking is limited in its application and consists of closing the openings by which rats leave a room, granary, silo, or other confined place, after they have entered during the night to feed. The animals can then be killed with poison, using the kind of food with which they have been prebaited, or with clubs, but precaution must be taken to guard against being bitten, for cornered rats may become vicious.

USE OF VIRUSES

Rat viruses on the American market contain living organisms, or bacteria, known as the Danysz bacillus, which when ingested by rats is said to cause a disease that is followed by great mortality. In extensive experiments with rats conducted by bacteriologists of the Department of Agriculture, however, even the most virulent cultures failed to produce a high percentage of deaths, while the majority of the viruses tested were practically ineffective. Also the disease produced was found not to be contagious, except when one rat ate another. Thus there is little probability of the disease spreading to an appreciable extent. There also appears to be well-founded doubt as to the harmlessness of rat viruses. The Danysz bacillus belongs to the same group as the food-poisoning bacilli and is indistinguishable from them generally. Although it has not been possible directly to trace many cases of human food poisoning to rat viruses some State boards of health have prohibited their sale. For these reasons the use of viruses for the destruction of rats is not recommended.

DEODORANTS

There is always the possibility that a rat will die in an inaccessible place, where its body will decay and cause obnoxious odors, particularly if near steam pipes or other warm place. In such cases the nuisance can be abated to some extent by the use of a deodorant that will absorb, neutralize, or destroy the offensive odors of putrefaction.

Of a number of deodorizing compounds tested in the laboratory, a saponated solution of cresol was found most effective in counteracting putrefactive odors. If possible, a small hole should be bored through the wall in the vicinity of the supposed point of origin and several tablespoonfuls of liquid inserted, after which the hole may be plugged. Pine-wood oil or perfume may also be added if desired. Zinc chloride may be used in the same manner.

A good deodorant can be made by dissolving ½ dram of lead nitrate in 1 pint of boiling water and then adding 2½ gallons of cold water in which 2 drams of salt have been dissolved. A large cloth should be saturated in the solution and hung in the room in which the odor is present.

Although no deodorant can be depended upon to destroy a disagreeable odor entirely, an application of one or more of the following may partially eliminate it.

Liquids (as a spray):

1. A saponated solution of cresol.
2. A saponated solution of cresol and pine or anise oil (10 drops to the gallon).
3. Sodium hypochlorite with or without anise or pine oil.
4. Formaldehyde sprayed on a carcass that can be reached but not removed.
5. Creosote sprayed where its odor and stain are not objectionable.
6. Zinc chloride (U. S. P. XI) (readily soluble in water) sprayed in the vicinity of inaccessible carcasses.

Powders (for dusting near a carcass):

1. Powdered chloride of lime.
2. Paradichlorobenzene.
3. Lead nitrate, to counteract the common putrefactive odor of flesh.
4. Naphthalene flakes.

Powder mixture (a solution mixture is given on page 24):

	Ounce
Finely pulverized paradichlorobenzene	1
Chloride of lime	1
Powdered chalk or talc	4

The three ingredients should be mixed and scattered, by means of a common garden duster, about the place from which the odor emanates. This mixture should be used as soon as prepared as it has a tendency to harden.

Theater sprays: Bennett (Chemical formulary, vol. 4, p. 92) gives several deodorant formulas that may be tried for overcoming lesser odors. A spray that may be recommended is as follows:

Water	1½ pints
Oil of—	
Cinnamon	1 teaspoonful
Cloves	1 teaspoonful
Wintergreen	1 teaspoonful
Peppermint	1 teaspoonful

NATURAL ENEMIES OF RATS

A good rat dog is almost indispensable on farms where old buildings offer ideal quarters for rats and constantly attract large numbers of them. Small terrier dogs, taught to hunt by themselves but trained not to kill young birds, will often keep a farm free from rats (fig. 10). Cats that are of real value as ratters are rare, and usually they are destructive to bird life. When confined, however, in warehouses, produce depots, and similar places in cities, good cats are sometimes of value in destroying rats and mice. Ferrets are of little use ordinarily except in the hands of experienced men aided by good rat dogs.

Although natural burrowers, rats do not ordinarily become excessively abundant in fields and woodlands, because of their numerous enemies among the smaller mammals and birds of prey. If the relation of hawks and owls to rat infestation on the farm were better

understood, the killing of such valuable birds would be limited to those actually caught preying upon the poultry, and others would be left to their work of reducing the number of rats and other injurious rodents. This policy would tend to lessen the numbers of the 3 species of hawks and owls that live to any considerable extent on

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***Figure 10.*—A small terrier dog, if taught to hunt by itself, will sometimes keep a farm free from rats.**

poultry and birds,[3] while the more than 40 beneficial species of predaceous birds of these groups would be spared.

COMMUNITY COOPERATION IN RAT CONTROL

Although getting rid of rats is to some extent an individual problem, an infestation has a serious effect on the whole community, and organized control effort is highly desirable. A person who allows rats to increase on his property until they menace the entire neighborhood becomes an object of public concern, and a city that permits its

[3] These harmful hawks and owls are Cooper's hawk (*Accipiter cooperi*), the sharp-shinned hawk (*Accipiter velox*), and the great horned owl (*Bubo virginianus*). The duck hawk (*Falco peregrinus anatum*) and the goshawk (*Astur atricapillus*) are also classed as injurious but are too rare to be of consequence. Cooper's and sharp-shinned hawks destroy 90 percent of the poultry and birds for which hawks and owls are responsible. The great horned owl is capable of great service in combating rats and other rodents and becomes a pest only where these are scarce and poultry is allowed to run at large. See Hawks and owls from the standpoint of the farmer, by A. K. Fisher. U. S. Dept. Agr., Bur. Biol. Survey Circ. 61, 18 pp., illus. 1907.

refuse dump to serve as a breeding ground for hordes of these pests is committing a grave injustice to its population. Ridding a whole community of rats can best be accomplished by the organized efforts of all the citizens working through interested public and private agencies. Campaigns of great value in stimulating popular interest and in disseminating the reasons for control have been conducted by governmental and local public-spirited organizations. Because rats are widespread and prolific breeders, a permanent working organization against them should be established in large cities and rural districts. In certain localities where this system has been in force for some time, it is proving effective in keeping down the numbers of rats.

ANTIRAT LEGISLATION

As already stated, the most important factors in general rat control are modern methods of construction and sanitation. For the most part modern construction is ratproof, and it could be made wholly so with little additional effort or cost. Legislation, however, is necessary to insure proper construction and to provide adequate facilities for the collection and disposal of waste. Several cities already have passed antirat ordinances, and many have regulations requiring fire stops in double walls, a necessary part of the control program. Rat-proofing should not end with the installation of fire stops, however, but should require, under rigid inspection, that all new structures be so planned and built that rats and mice will not be able to gain ready entrance or find shelter if they do get in.

Such regulations are urgently needed if the rat is to be shut out of every new structure and ultimately built out of the country and possibly out of existence.

SUMMARY

The five essential steps in rat control, in order of importance, are as follows:

1. Permanent rat-control organizations should be provided for large cities and rural districts.
2. All shelter for rats should be eliminated and all garbage, trash, and other waste on which rats can feed should be promptly disposed of.
3. All buildings should be made ratproof.
4. The rats themselves should be destroyed by use of poisoned baits and traps. If it is desired to avoid the slight risk of rats dying in inaccessible places, traps should be used. Rat burrows and hiding places should be fumigated with poisonous gases.
5. Natural enemies of the rat should be protected when they are not themselves destructive.

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